Long-term deformations of fastening systems under sustained loads

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Abstract:

Fastening elements are used to connect structural members with each other and with appliances. In general post-installed fastening systems are characterized as either mechanical anchors or so called bonded or chemical anchors. The working principle of the former is friction or mechanical interlock while the performance of the latter is based on the adhesive properties of polymer mortars – mostly epoxy or vinyl-ester based. Both mechanical as well as chemical anchors undergo an approval process during which their performance is certified. These tests are performed according to strict guidelines. In recent years two prominent disasters created significant concerns regarding the performance of bonded anchors under sustained loads. Thus, current approval guidelines regarding the qualification of bonded anchors systems are being challenged and the introduction of penalty factors for sustained loads is being discussed. Interestingly, all long-term deformations are being attributed to the adhesive only, neglecting contributions from concrete as well as damage and system effects. In this contribution we attempt to quantify the effect of (a) concrete creep, and (b) stress redistribution and damage mechanisms based on state of the art numerical simulations, calibrated by material tests and validated by system tests. Specifically, an epoxy based and a vinyl-ester based system are investigated and compared to the performance of headed-studs. The numerical framework is able to model the coupled problem of heat- and moisture transport, hydration, ageing of material properties, shrinkage and creep in a rate-type, pointwise form. For the constitutive model the Lattice Discrete Particle Model (LDPM) is used.

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